

The foraging ball as a quick and easy enrichment device for pigs (*Sus scrofa*)

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Providing research pigs with enrichment objects can encourage species-typical behavior such as rooting and foraging. The authors gave pigs hard plastic 'foraging balls' that resembled enrichment devices commonly used for nonhuman primates. Holes were custom-drilled into the balls, and animal caretakers filled them with palatable food items such as jellybeans, unsalted peanuts, cereal, Beggin' Strips, primate biscuits and dog biscuits. Staff members suspended the balls from chains in pigs' enclosures, ensuring that toys did not touch the floor. All pigs manipulated the balls and were able to obtain treats that were supplemental to their standard diet. The simple and effective enrichment device was easily incorporated into the daily routines of research facilities, with little disruption to schedules.

The use of swine in research has increased since the 1980s (ref. 1), increasing the need to understand and promote species-typical behavior in these animals. Pigs have unique behavioral and husbandry requirements. They are social creatures that spend most of their active time foraging or rooting for food²⁻⁴. Despite many generations of genetic selection, pigs still show this exploratory behavior⁵ as a means of satisfying hunger or curiosity and reducing boredom⁶.

Laboratories can create conditions that encourage rooting and exploratory behavior in research pigs. This may limit the expression of atypical behavior. Researchers found that pigs housed in a barren environment were less active, showed less play and explorative behavior and demonstrated more maladaptive behavior (oral manipulation of penmates) compared with pigs reared in enriched environments⁷. Additional studies have reported that pigs housed under barren conditions are more aggressive than those raised in more stimulating environments⁸⁻¹⁰. One form of maladaptive behavior that can result from lack of enrichment is tail biting. Tail biting is thought to be a type of suckling, social, sexual, exploratory or feeding behavior that is misdirected onto the tails of penmates¹¹. This behavior is a particular problem in weanlings¹²; a lack of environmental stimulation such as rooting material¹³

exacerbates their motivation to suckle so that the mere shape of the tail triggers the suckling response¹¹. The findings of these studies suggest that pigs housed in barren environments differ behaviorally from pigs housed under enriched conditions.

This marked contrast in behavior has probably contributed to the rising concern regarding housing conditions of agricultural animals. In the 1960s, publications reviewing animal welfare conditions in the United Kingdom and elsewhere enhanced public awareness of common practices on the farm and focused public scrutiny on the housing and welfare of agricultural animals^{14,15}. As a result, formal operating procedures for animal care and welfare have since been implemented in the UK¹⁶. These standards have influenced the development of US guidelines that address the behavioral needs of farm animals^{7,11}. Correspondingly, enhanced enrichment programs have been developed for pigs^{5,17-21}.

The success of a supplemental enrichment program often depends on the ease of implementation and the safety of items involved²². The purpose of this project was to identify a novel and simple way to distribute food supplements to research pigs as an enhancement to an established enrichment program. Enrichment programs for nonhuman primates may include

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‘challenger balls’ (Bio-Serv, Frenchtown, NJ; hereafter referred to as ‘foraging balls’), which provide animals with opportunities to engage in species-typical behavior²³. Pigs may benefit from similar stimuli: just as foraging balls help satisfy primates’ need to forage, such items may enrich pigs’ lives by satisfying their intense need to chew and root.

In this project, foraging balls, similar in conceptual design to the ‘Edinburgh Foodball’²¹, were custom-adapted at facilities of the National Institutes of Health (NIH). Animal care staff filled hard plastic balls with various food items and suspended them inside pig kennel enclosures on a rotational basis. We observed pigs to determine whether they would manipulate the foraging balls by showing rooting behavior. We found that this type of feeding enrichment provided an outlet for pigs to engage in species-typical behavior under laboratory conditions. We hope to demonstrate that supplemental feeding can be a simple, effective adjunct to an existing enrichment program.

Pigs

All enrichment procedures described below were reviewed and approved by the ACUC of the NIH Division of Veterinary Resources. We used domestic and miniature pigs (*Sus scrofa*) that were housed at the NIH animal center in Poolesville, MD and on the main NIH campus in Bethesda, MD.

MATERIALS

We obtained hollow balls made of hard plastic (Jolly Balls; Otto Environmental, Milwaukee, WI; 33.5 cm diameter). Approximately eight large holes (2.5–3.2 cm in diameter) were custom-drilled in the upper and lower hemispheres of each ball at arbitrary locations (Fig. 1). Several small holes (<1.3 cm diameter) were drilled into the bottom of each ball to allow for water drainage without allowing the treats to fall out too quickly. We passed a length of stainless steel straight-link chain (121.9 cm long; 0.5 cm diameter) through two large holes at the top of the ball and connected the chain to itself using a quick-link connector (0.5-cm diameter; threaded connectors). We attached another quick-link connector or double-ended snap hook to the other end of the chain, making it possible to clip the foraging ball onto hanging structures above the pig kennels. We measured chains and cut them to length to keep the balls from dragging on the floor. This prevented balls from being soiled, thereby prolonging pigs’ interest in the toys²⁴.

Enrichment procedure

All pigs were socially housed unless restricted by protocol or for medical reasons. The standard program of environmental enrichment for pigs housed at NIH consists of a flake of straw or hay (one slice of a bale, approximately



FIGURE 1 | Foraging ball.

38.1 cm long × 50.8 cm wide × 15.2 cm thick) distributed into the kennel or pen on a monthly schedule.

We gave pigs access to foraging balls on a rotational basis for supplemental food enrichment. The standard diet was not altered, and all pigs received normal rations. We developed a schedule that specified the dates and times when individual pigs would receive foraging balls. Schedules were distributed to care staff and were updated monthly, depending on the number of pigs residing in the buildings. Staff members filled the balls with palatable items such as jellybeans, unsalted peanuts, cereal, Beggin’ Strips (Nestlé Purina, St. Louis, MO) and primate or dog biscuits. For pigs housed on expanded floor grates, food items had to be large enough so that they wouldn’t fall through the grate when shaken loose from the ball. Balls were clipped to the side of the caging and swung clear of the flooring to prevent soiling and anticipated rejection of the toy²⁴.

Care staff filled and distributed foraging balls to 22 pigs after cleanings. This process took 30 min total. Pigs had continuous access to the balls. Over the course of a month, staff members refilled each ball every 2 d (excluding weekends). Refilling all 22 balls consumed on average 15 min of the caretaker’s time. We observed 11 pigs for 20 min after placement or refilling of the balls. All of the pigs interacted with the balls and were able to obtain supplemental food enrichment. Using their noses, they pushed the balls up and from side to side (Fig. 2). As long as food items were still available inside the balls, the pigs were able to get enrichment items as they fell out and onto the floor below. Pigs manipulated the foraging balls for approximately 6 min (mean was 5.7 min ± 3.3 s.d.) and successfully removed the treats. When food had been completely distributed, manipulation ended. This result is common in studies of similar enrichment devices such as the Edinburgh Foodball²¹ and challenger balls given to nonhuman primates²³. The supplemental treats did not interfere with or prevent complete ingestion of normal rations.



FIGURE 2 | Two pigs using the foraging ball at the NIH Animal Center in Poolesville, MD.

DISCUSSION

In the wild, pigs root on and under the ground for food²⁴. Similar behavior can be encouraged in the laboratory by providing pigs with a hanging ball filled with food treats. This device gives pigs an opportunity to forage for novel foods as part of a comprehensive enrichment program. The ball described here did not roll on the floor, eliminating the possibility of floor drain blockage²² and contamination of the ball with manure, which is reported to cause enrichment avoidance²⁴. The foraging balls were simple to design, build and regularly implement as hazard-free enrichment for pigs. Moreover, supplemental foodstuffs, which are rewarding for pigs, may promote their welfare under laboratory conditions.

The European Union has mandated that pigs must have stimulating environments to minimize aggression, prevent boredom and avoid the development of stereotypic behaviors such as chewing and biting of the tail, ear and flank, as well as navel sucking¹⁶. Facilities may provide pigs with opportunities to engage in species-typical behavior such as grazing and rooting for food, as well as social interaction. Pigs are given access to pastures, are provided with straw or hay and are given manipulable objects similar to the foraging balls described here. Items are rotated to prevent possible habituation to enrichment, ultimately leading to rejection¹⁶.

In NIH facilities, pigs are provided with both straw and the foraging ball from which they obtain highly preferred treats. Without supplemental enrichment, a pig's intense need to root may become misdirected towards inappropriate targets such as itself, penmates or the enclosure²⁵. In general, a program of environmental enrichment may help to prevent maladaptive behaviors in laboratory animals. The device described stimulates rooting behavior and serves as one component of a comprehensive enrichment program. The more outlets pigs have to express species-typical behavior, the

less aggression they may display towards cagemates or human care staff, and the more explorative they become²⁶. Enrichment may contribute positively to an animal's adaptation to low-level stressors or changes occurring within its environment²⁷.

The requirements for enrichment in pigs can be easily met. The simple provision of rooting material, for example, may attenuate adverse behavior such as tail biting, which is thought to be a product of stress¹¹. Nevertheless, individuals responsible for the well-being and welfare of laboratory animals continue to face challenges. Research protocols may limit or prevent the provision of supplemental enrichment to research animals. Moreover, unfamiliar devices may cause entanglement or injury. We have shown here that a simple food delivery system that is safe and easy to build can become an integral part of a comprehensive environmental enrichment program for pigs.

A good enrichment program improves the welfare and well-being of all animals, especially those housed in biomedical laboratories. Enrichment for laboratory species such as pigs that are not covered by the Animal Welfare Act is a relatively new concept. One of the stated goals of the *Guide for the Care and Use of Laboratory Animals* is the promotion of humane care of animals used in research²⁸. Providing laboratory pigs with supplemental foraging opportunities such as those described here addresses this goal. Enhancement to any enrichment plan should mesh well with ongoing research and may ultimately result in better research data and refinement in animal models.

ACKNOWLEDGMENTS

We gratefully acknowledge the contributions of the technical support staff, particularly Blair Casey and Tia Brown, responsible for promoting and implementing these enrichment supplementations. J.L.W. is supported by the Intramural Research Program of the NIH, Division of Veterinary Resources, Office of Research Services.

Received 1 February; accepted 9 April 2008
Published online at <http://www.labanimal.com/>

COMPETING INTERESTS STATEMENT

The authors declare no competing financial interests.

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